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Title:
High Precision Radiometric Dating of Sedimentary Materials

Persons in Charge:
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Objectives:
To develop field, petrographic and geochemical criteria to allow high precision U-Pb dating of sedimentary minerals within rapidly deposited sequences of carbonate and clastic rocks

Results:
Our original goal was to obtain radiometric ages for biostratigraphically controlled syn-sedimentary material with uncertainties of three million years or less to precisely date the times of sedimentation. We have shown that it is possible in some circumstances to obtain uncertainties of 1 Ma or less. Our focus has been on areas of rapid sedimentation from marine and terrestrial records where the duration of formation of the syn-sedimentary minerals is smaller than the age uncertainty. We have published high precision U-Pb ages for calcite in paleosols (caliche), in marine limestones and within siliciclastic fluvial facies. We have also been able to date calcite (altered from aragonite) that formed within an evaporite sequence, and as open marine cements. Additionally, a variety of lacustrine (lake) limestones have provided high precision ages.

In order to get high precision ages it is necessary to have relatively high U/Pb ratios. In most cases this requires enrichment of the samples in uranium. In order to increase the probability of

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obtaining samples enriched in U for dating, we have sought to understand how U is fixed in dated minerals from different environments. For example, a caliche sample, dated at 298 +/- 1 Ma is highly enriched in organic material. The presence of organic material suggests that the sample formed under reducing conditions. Other lines of evidence for reducing conditions include pyrite lining fossil roots and bright orange luminescence indicating incorporation of Mn(II) in the calcite. XANES data indicate that U(VI) the oxidized species is dominant .

Conversely, a sequence of lacustrine carbonates with ages from 15.28 +/- 0.29 to 16.25 +/- 0.22 Ma are without obvious organic matter but have elevated U abundances (100's of ppm). However, the U consists of the reduced species of U(IV). These samples formed at a lake margin, which presumably was at least suboxic. By working to determine how U is incorporated in precisely dated samples we are able to make significant contributions to understanding the conditions that might immobilize and enrich U on geologic timescales. These studies are highly relevant to geochronology and to issues of nuclear waste management.

Key Words

Uranium, U/Pb dating, radiometric ages, carbonates, XANES, biostratigraphically controlled, sedimentary record

Publications

Rasbury, E.T., Hanson, G.N., Meyers, W.J., and Saller, A.H., Dating the time of sedimentation using U-Pb ages for paleosol calcite, Geochim. Cosmochim. Acta, 61, 1525-1529 (1997).

Rasbury, E.T., Hanson, G.N., Meyers, W.J., Goldstein, R.H and Saller, A.H, U-Pb dates of Paleosols: Constraints on late Paleozoic cycle durations and boundary ages, Geology, 26, 403-406 (1998)

Wang, Z.S., Rasbury, E.T., Hanson, G.N. and Meyers, W.J., Using the U-Pb system of calcretes to date the time of sedimentation of clastic sedimentary rocks, Geochim. Cosmochim. Acta, 62, 2823-2835 (1999)

Rasbury E.T., Meyers W.J., Hanson G.N. Goldstein, R.H. , Saller, A. Relationship of uranium to petrography of caliche paleosols with application to precisely dating the time of sedimentation, Jour. Sed. Res. 70, 604-618 (2000)

Becker M.L., Cole J.M., Rasbury E.T., Pedone, V.A., Montañez, I.P., and Hanson G.N. Cyclic variations of uranium concentrations and oxygen isotopes in tufa from the middle Miocene Barstow Formation, Mojave Desert, California, Geology 29, 139-142 (2001)

Becker ML, Rasbury ET, Meyers WJ, Hanson GN, U-Pb calcite age of the Late Permian Castile Formation, Delaware Basin: a constraint on the age of the Permian-Triassic boundary (?), Earth and Planetary Sci Letters, 203, 681-689 (2002)

Cole JM, Nienstedt J, Spataro G, Rasbury ET, Lanzirotti A, Celestian AJ, Nilsson M, Hanson GN, Phosphor imaging as a tool for in situ mapping of ppm levels of uranium and thorium in rocks and minerals, Chemical Geology 193, 127-136 (2003).

Becker ML, Rasbury ET, Meyers WJ, Hanson GN, "U-Pb calcite age of the Late Permian Castile Formation, Delaware Basin: a constraint on the age of the Permian-Triassic boundary(?)": Reply to a comment by Ian Metcalfe, Earth and Planetary Sci Letters, 217, 269-271-689 (2004)

Cole, J.M., Rasbury, E.T., Montañez, I.P., Pedone, V.A., Lanzirotti, A., and Hanson, G.N. Petrographic and trace element analysis of uranium-rich tufa calcite, middle Miocene Barstow Formation, California, USA. Sedimentology 51(3): 433-453 (2004)

Rasbury ET, Ward WB, Hemming NG, Li H, Dickson JAD, Hanson GN, Major RP, Concurrent U-Pb age and seawater Sr-87/Sr-86 value of a marine cement, Earth and Planetary Science Letters, 221, 355-371 (2004)

Cole, J.M., Rasbury, E.T., Hanson, G.N., Montañez, I.P., Pedone, Using U-Pb ages of Miocene tufa for correlation in a terrestrial succession, Barstow Formation, California, GSA Bull. 117, 276-287 (2005)